U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
PB80-125297

Wine Production from Cheese Whey

Foremost McKesson, Inc, Dublin, CA

Prepared for

Industrial Environmental Research Lab, Cincinnati, OH

Oct 79

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/2-79-189	2.
3. RECIPIENT'S ACCESSION NO. PB 80 125297	
4. TITLE AND SUBTITLE WINE PRODUCTION FROM CHEESE WHEY	5. REPORT DATE October 1979 issuing date
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Gaylord M. Palmer	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Foremost McKesson, Inc. Dublin, California 94566	10. PROGRAM ELEMENT NO. 1BB610
	11. CONTRACT/GRANT NO. S-803863
12. SPONSORING AGENCY NAME AND ADDRESS Industrial Environmental Research Laboratory Office of Research and Development U.S. Environmental Protection Agency Cincinnati, Ohio 45268	13. TYPE OF REPORT AND PERIOD COVERED Final Report 10/75 - 6/78
	14. SPONSORING AGENCY CODE EPA/600/12

15. SUPPLEMENTARY NOTES

16. ABSTRACT

The objective of this project was to demonstrate commercial feasibility of producing an alcoholic beverage by wine yeast fermentation of supplemented cheese and cottage cheese wheys.

Results indicated that the preferred processing route was (1) fractionation of the whey into protein concentrate and permeate by ultrafiltration; (2) supplementation of permeate with twenty two percent dextrose on the permeate weight; (3) fermentation in stirred fermentors for seven to ten days at 20°-22°C.; (4) clarification of the ferment by centrifugal means followed by pressure filtration; (5) demineralization of the ferment by ion exchange; (6) formulation of the beverage by addition of natural fruit flavor concentrates, invert syrups, malic acid, and water to standardize alcohol content at about eight percent by volume; (7) polishing filtration through diatomaceous earth and a 0.45 micron membrane filter; (8) carbonation with two volumes of carbon dioxide and (9) bottling with a pressure retaining cap.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Food Industry Cheese Byproduct Economics	Whey Wine Production	96 B 98 H

18. DISTRIBUTION STATEMENT Release to Public	19. SECURITY CLASS *(This Report)* UNCLASSIFIED	21. NO. OF PAGES 77
	20. SECURITY CLASS *(This page)* UNCLASSIFIED	22. PRICE PC A05 MF A01

EPA Form 2220-1 (Rev. 4-77)

* U.S. GOVERNMENT PRINTING OFFICE: 1979-657-146/5479

United States
Environmental Protection
Agency

Industrial Environmental Research
Laboratory
Cincinnati OH 45268

EPA-600/2-79-189
October 1979

PB80-125297

Research and Development

EPA

Wine Production from Cheese Whey

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

RESEARCH REPORTING SERIES

Research reports of the Office of Research and Development, U.S. Environmental Protection Agency, have been grouped into nine series. These nine broad categories were established to facilitate further development and application of environmental technology. Elimination of traditional grouping was consciously planned to foster technology transfer and a maximum interface in related fields. The nine series are:

1. Environmental Health Effects Research
2. Environmental Protection Technology
3. Ecological Research
4. Environmental Monitoring
5. Socioeconomic Environmental Studies
6. Scientific and Technical Assessment Reports (STAR)
7. Interagency Energy-Environment Research and Development
8. "Special" Reports
9. Miscellaneous Reports

This report has been assigned to the ENVIRONMENTAL PROTECTION TECHNOLOGY series. This series describes research performed to develop and demonstrate instrumentation, equipment, and methodology to repair or prevent environmental degradation from point and non-point sources of pollution. This work provides the new or improved technology required for the control and treatment of pollution sources to meet environmental quality standards.

This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

EPA-600/2-79-189
October 1979

WINE PRODUCTION FROM CHEESE WHEY

by

Gaylord M. Palmer
Foremost McKesson, Inc.
Dublin, California 94566

Grant No. S-803863

Project Officers

Max W. Cochrane
and
Kenneth A. Dostal
Food and Wood Products Branch
Industrial Environmental Research Laboratory
Cincinnati, Ohio 45268

INDUSTRIAL ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

DISCLAIMER

This report has been reviewed by the Industrial Environmental Research Laboratory, U.S. Environmental Protection Agency, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

FOREWORD

When energy and material resources are extracted, processed, converted, and used, the related pollutional impacts on our environment and even on our health often require that new and increasingly more efficient pollution control methods be used. The Industrial Environmental Research Laboratory-Cincinnati (IERL-Ci) assists in developing and demonstrating new and improved methodologies that will meet these needs both efficiently and economically.

This report describes the pilot plant studies on conversion of cheese whey into a by-product---wine. The results were successful and an economic evaluation estimates the cost at $0.66 to $0.94 per liter of bottled product.

For further information regarding this study, contact the Food and Wood Products Branch, Industrial Pollution Control Division, Industrial Environmental Research Laboratory-Ci, Cincinnati, Ohio 45268.

David G. Stephan
Director
Industrial Environmental Research Laboratory
Cincinnati

ABSTRACT

The objective of this project was to demonstrate commercial feasibility of producing an alcoholic beverage by wine yeast fermentation of supplemented cheese and cottage cheese wheys.

An experimental pilot scale winery was established to produce alcoholic beverages by fermenting supplemented wheys in 1,100 liter quantities. Auxiliary processing equipment was assembled to clarify, demineralize, flavor and carbonate the beverages.

The fermenting organism exclusively was the Montrachet strain of wine yeast; the fermentable carbohydrate was dextrose.

Results indicated that the preferred processing route was (1) fractionation of the whey into protein concentrate and permeate by ultrafiltration; (2) supplementation of permeate with twenty two percent dextrose on the permeate weight; (3) fermentation in stirred fermentors for seven to ten days at 20^{o}-22^{o}C.; (4) clarification of the ferment by centrifugal means followed by pressure filtration; (5) demineralization of the ferment by ion exchange; (6) formulation of the beverage by addition of natural fruit flavor concentrates, invert syrups, malic acid, and water to standardize alcohol content at about eight percent by volume; (7) polishing filtration through diatomaceous earth and a 0.45 micron membrane filter; (8) carbonation with two volumes of carbon dioxide and (9) bottling with a pressure retaining cap.

A beverage made by the preferred process was tested by an independent market research group against Annie Green Springs Berry Frost in paired comparisons at three geographic locations in the United States - using 450 respondents in all. The conclusion of the test was that, "in terms of both the levels of strong, positive response, as well as the mean ratings, there was no significant differences between the two products."

Economic evaluation - projected from the pilot study - indicates that the cost of manufacture of whey wine falls into the range of $0.66 to $.94 per liter of bottled product.

This report was submitted in fulfillment of Grant No. S-803863 by Foremost Mc Kesson, Inc. under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period October 14, 1975 to June 30, 1978.

CONTENTS

Foreword		iii
Abstract		iv
Figures		vi
Tables		vii
Acknowledgements		viii
I	Introduction	1
II	Summary	3
III	Conclusions	5
IV	Experimental Plant	6
V	Methods and Procedures	8
	Sensory Evaluation	8
	Marketing Research	19
VI	Process Development	25
	Confirming Oregon State University Benchtop Results	25
	Deproteinization	25
	Supplementation of the Permeate	28
	Fermentation	28
	Removal of Yeast Biomass	28
	Demineralization	30
	Polishing Filtration	38
	Carbonation	38
VII	Process Flow and Material Balances	39
VIII	Flavored FWB (FFWB) Development	42
	Selecting the Target Wine	42
	Selecting the Flavor System	42
	Developing the Flavoring System	43
IX	Sensory Evaluation	45
	Descriptive Flavor Analysis	45
	Paired Comparison Preference Tests	45
	Applications to Process Development	45
X	Economic Evaluation	46
XI	Marketing Research	48
XII	Legal Requirements	49
References		50
Appendices		
A.	Descriptive Flavor Analysis	51
B.	Economics of Fermented Whey Beverage Processing	54

FIGURES

NUMBER		PAGE
1.	Wine taste test questionnaire used in in-house sensory evaluation testing	11
2.	Wine taste test questionnaire used in consumer sensory evaluation testing	14
3.	Wine taste test questionnaire used in marketing research central location testing	20
4.	Process flow diagram and material balances for FFWB from acid whey	40
5.	Process flow diagram and material balances for FFWB from sweet whey	41

TABLES

NUMBER		PAGE
1.	Example of Descriptive Flavor Profiles	9
2.	Analysis of UF Permeates From Whey	27
3.	Refractometer Solids and pH Measurements with Time Showing the Course of Normal Fermentation of Permeate	29
4.	Refractometer Solids and pH Measurements with Time Showing Lack of Fermentation in IE Permeate, and Fermentation Following Supplementation with Whole Whey	32
5.	Refractometer Solids and pH Measurements with Time Showing Effects of Added Supplements to IE Permeate on Fermentation Rates	33
6.	Refractometer Solids and Titratable Acidity Measurements with Time Showing Effect of Percent Demineralization of Permeate by ED on Fermentation Rates	34
7.	Sensory Evaluation Report Showing Comparability of Electrodialysed FFWB and Ion Exchanged FFWB in Terms of OVERALL and PREFERENCE Ratings	35
8.	Sensory Evaluation Report Showing Comparability of Electrodialysed FFWB and Ion Exchnaged FFWB in Terms of ATTRIBUTE Ratings	36
9.	Summary of Processing/Bottling Costs for FFWB Product	47

ACKNOWLEDGEMENTS

This project was supported by a demonstration grant from the Environmental Protection Agency, and the assistance of Max W. Cochrane and Kenneth A. Dostal (Project Officers) is acknowledged with thanks.

Recognition for assistance in the success of the project must go to other members of the Foremost Research and Development group: to William A. Hoskins for his help in administering the project; to Donald F. Wilcox for initial screening of flavoring systems; to Robert F. Marquardt for his untiring efforts in developing processing and optimizing the flavor system, developing material and energy balances and processing costs; and to Kathy A. Wolfe for the several types of sensory evaluation required in pursuit of the goal.

Thanks are also extended to Richard Wood of Foremost Foods Marketing Research for central location consumer tests which demonstrated marketability of the product.

SECTION I

INTRODUCTION

Based on information published[1] by the United States Department of Agriculture (USDA), 13.6 billion kilograms of whey were produced in the United States in 1973, as by-products of the manufacture of hard cheeses such as cheddar, mozzarella, jack and swiss and of cottage cheese. Of that whey, USDA estimated that although 7.7 billion kilograms were recovered in the forms of dried whey and modified whey, whey concentrates and lactose, 5.9 billion kilograms were unutilized. Reports for 1976 indicate 5 billion kilograms were unutilized.

That unutilized portion became either an environmental pollutant -- being sprayed onto wasteland or dumped into rivers, streams or unused gravel pits -- or an added consumer cost -- being cycled to municipal wastewater treatment facilities for purification prior to discharge to ground water systems.

The Federal Water Pollution Control Act, as amended by the Water Quality Act of 1965, has led to development of extensive water quality control programs at federal, state and local levels to control the disposal of materials such as whey. Compliance with those water quality standards, in a manner which will permit their business to survive, is a major concern to the small cheese manufacturer, isolated from the major whey processors who convert whey into useable and profitable products.

Cheese production, and as a consequence, whey production, is increasing yearly; USDA reported[2] production of 16.8 billion kilograms of whey in the United States in 1976, in contrast to 13.6 billion kilograms in 1973, an increase of nearly 25 percent in three years.

Although more whey is being recovered as useable products, the pollution problem has not diminished significantly.

To convert whey into useful dried products requires large amounts of energy (a) to remove the water from the dilute raw whey (about 6.5 percent total solids content) (b) in thermal evaporation and (c) in spray drying operations. It also requires collection and transport of that whey to central whey processors, which is costly in energy.

Much of the reason for whey pollution lies in the unfavorable economics of collecting and transporting it from small or isolated cheese manufacturers in small communities located in or near the rural milk producing areas.

To circumvent those economics and to find a way to convert whey -- at its source -- into a useful and marketable product, Oregon State University (OSU) working under U.S. Environmental Protection Agency (EPA) Grant No. 803301, demonstrated the technical feasibility of fermenting supplemented whey into an alcoholic beverage.

Based on the success of that project, Foremost Foods Company a Division of Foremost McKesson, Inc., was granted the subject project to demonstrate commercial feasibility of producing an alcoholic beverage by wine yeast fermentation of cheese whey or supplemented cheese whey followed by flavoring.

SECTION II

SUMMARY

Processing of either sweet cheese whey (from hard cheese manufacture) or acid whey (from cottage cheese manufacture) into a marketable flavored fermented whey beverage (FFWB) has been demonstrated as a means to reduce environmental pollution and to provide the cheese manufacturer a revenue producing product from whey.

The process produces, from either type of whey, a fermented whey beverage base (FWB) characterized by Descriptive Flavor Analysis (DFA) as having a slight to moderate alcohol taste, a slight sweet taste and threshold to slight sour and fruity notes. By analysis the FWB has about 9.5 percent alcohol and the FFWB an 8 percent alcohol by volume.

The FFWB is produced by flavoring the FWB with natural fruit flavor concentrates, sweetening with 50% invert syrup, acidifying slightly with malic acid, standardizing to the required alcohol content with water, filtering to remove haze components, carbonating to 1.8 volumes of carbon dioxide and bottling.

The process comprises eight major steps from whey to FFWB

- deproteinization by ultrafiltration to produce a whey protein concentrate by-product (WPC) and a water clear deproteinized whey permeate (Permeate) for fermentation,
- supplementation with dextrose as a fermentable carbohydrate,
- fermentation by wine yeast,
- clarification by centrifugation and/or filtration,
- demineralization by ion exchange or electrodialysis,
- formulating into FFWB,
- carbonating and
- bottling.

Although the process requires several steps, each in its own right is simple and straight-forward and requires little in the way of process control.

The process by-products consist of:

- a protein rich WPC from the deproteinization step,
- a yeast rich concentrate from the clarification step,
- mineral rich effluent stream from the de-mineralization step.

The protein rich by-product is of the nature that is currently an article of commerce (in the dried form) or an article of recycle into cheese product manufacture or other dairy use.

The yeast rich concentrate is small in quantity, but is suited to recycle to dairy farm operations as a feed supplement.

The mineral rich effluent is low in BOD; and is suitable for cycling to treatment systems directly.

SECTION III

CONCLUSIONS

1. Commercial feasibility of manufacturing a fermented alcoholic beverage from sweet cheese or cottage cheese whey has been demonstrated by production on a semi-commercial scale in an experimental winery followed by consumer testing.

2. Manufactured cost of flavored, sweetened and carbonated FWB -- based on the system developed in this project -- projected from the semi-commercial scale, are indicated to be in the neighborhood of $0.61 to $0.88 per liter of finished product, bottled in one liter bottles.

3. Pollution reduction due to manufacture of FWB in preference to sewering the whey is on the order of 75% - 90%.

4. In terms of both the levels of strong, positive response, as well as the mean ratings, there were no significant differences between the FFWB and the commercial target wine (Annie Green Springs Berry Frost).

SECTION IV

EXPERIMENTAL PLAN

PRINCIPLE OBJECTIVE

The principle objective of the study is to demonstrate commercial feasibility of producing an alcoholic beverage by wine yeast fermentation of sweet and acid cheese wheys, or supplemented wheys, followed by flavoring.

SUBORDINATE OBJECTIVES

1. To transfer a bench scale "whey wine" fermentation process developed by OSU under EPA Project No. R-803301 to a pilot process, making use of applicable dairy and cheese plant equipment and technology; and determine consumer response to the product of that transfer.

2. To adjust the pilot process to:

   - fermentation of cheese wheys other than cheddar,
   - fermentation of cottage cheese (acid) whey,
   - fermentation by a selected lactose fermenting yeast,
   - fermentation of wheys deproteinized by membrane processing, and
   - other processing steps as time permits and experience warrants.

3. To relate the process adjustments to the resultant products by means of analytical and sensory evaluation and select at least one process variant for final development based on those evaluations.

4. To develop a flavored variant of the whey wine -- with or without carbonation -- and determine consumer acceptance, comparing it with a leading commercial flavored wine.

5. To develop production economics, by projecting from pilot experience, for the OSU process and product and for other processes and/or product variations, including flavored and unflavored products.

6. To characterize residues, if any, of the selected processes and recommend potential end uses.

7. To determine legal requirements to ferment alcoholic beverages in a dairy or cheese plant environment; and labeling requirements for the products.

SECTION V

METHODS AND PROCEDURES

SENSORY EVALUATION

Throughout this project, two basic sensory testing methodologies were used to guide product and process development; Descriptive Flavor Analysis (DFA) and preference/acceptance testing. These are briefly described below, and in more detail in Appendix B.

The Foremost Descriptive Flavor Analysis Panel uses a method of analysis developed by Arthur D. Little Company. DFA describes in proper perspective all detectable characteristics of the aroma and flavor of a product. The method provides a complete word description ("analysis" or "profile") of a sample (Table 1.). The Profile method requires a panel of four to six trained flavor analysts who function as a unit under the direction of a panel leader to produce a word description of the product. The panel assigns intensity levels to each character note using a 7-point scale ranging from threshold to strong. Thus, specific sensory differences between two or more products can be identified and quantified.

Paired comparison preference/acceptance testing was conducted with either a minimum of 30 Foremost R&D employees or a minimum of 50 naive, male and female adult consumers who had consumed a "pop wine" within the past month and had a positive or neutral attitude towards berry flavor. Employees were used in early and middle stages of product formulation (Figure 1.), while consumers were used in the latter stages, as the formulation/process became more finalized (Figure 2.). In either case, the preference and/or acceptance test is conducted comparing two products. These can be served side-by-side or sequentially, each coded with different randomly selected, two digit numbers. The samples are served chilled and in balanced order, each being served first an equal number of times, to prevent positional bias. Normally, white lights are used since color differences, if any, contribute to the overall preference/acceptance rating. However, in some preference tests with employees, red/blue lights were used to mask color differences. In these tests, color identified whether the sample was a "Foremost" or the commercial product. In order to maintain a "blind" test (products not identified), color was necessarily masked.

TABLE 1. EXAMPLE OF DESCRIPTIVE FLAVOR PROFILES

DESCRIPTIVE FLAVOR ANALYSIS — 994-RG

Whey Wine — 2/14/77

AROMA

	No Ion Exchange		Ion Exchange	
	Mozz. Whey #012.771	Jack Cheese* Whey #062.76	Mozz. Whey #012.772	Jack Cheese* Whey #077.76
Alcohol	1-2	2	1-2	1-2
Briny	X-1	X-1	X-1	X-1
Yeasty	X-1	X-1	-	-
Whey	X-1	X-1	X-1	-
Wine/fruity	1	1	X-1	1
Acid	-	X-1	-	1
Fermented	1	1	X-1	1
Sweet	X-1	X-1	1	X-1
Sulfur Compounds	-	-	-	1
Resinous	-	-	-	1
Feeling Factor				
Slightly astringent	+	+	+	+
Thinner	-	-	+	-

Scale

X = Threshold

1 = Slight

2 = Moderate

3 = Strong

* These two products were profiled at an earlier time on 3/31/76. They are included here for ease of comparison.

(continued)

TABLE 1. (continued)

DESCRIPTIVE FLAVOR ANALYSIS

994-RG

2/14/77

Whey Wine

FLAVOR-BY-MOUTH

	No Ion Exchange		Ion Exchange	
	Mozz. Whey #012.771	Jack Cheese* Whey #062.76	Mozz. Whey #012.772	Jack Cheese* Whey #077.75
Alcohol	1-2	1-2	1-2	1-2
Sour	X-1	1	X-1	1
Salty	1-2	1	X	X
Whey	1	X-1	X	-
Bitter	X-1	X-1	-	X
Sweet	X-1	X-1	1	1
Fruity	-	1	X-1	1
Aftertaste				
Sour	-	+	-	+
Salty	+	+	-	+
Alcohol	+	+	+	+
Sweet	-	-	+	-

Key For Symbols

+ = Present

- = Not Present

* These two products were profiled at an earlier time on 3/30/79. They are included here for ease of comparison.

Date _____ Project No. 994-RG

Name _____

WINE

You have in front of you two samples of wine. Taste each wine from left to right, drinking some water in between.

1. Please rate each wine on the following scale:

	# _____	# _____
Like extremely	_____	_____
Like very much	_____	_____
Like moderately	_____	_____
Like slightly	_____	_____
Neither like nor dislike	_____	_____
Dislike slightly	_____	_____
Dislike moderately	_____	_____
Dislike very much	_____	_____
Dislike extremely	_____	_____

2. Now, please rate each wine on the following attributes:

		# _____	# _____
	Definitely too sweet	☐	☐
	Slightly too sweet	☐	☐
SWEETNESS	Just right	☐	☐
	Slightly not sweet enough	☐	☐
	Definitely not sweet enough	☐	☐

Figure 1. Wine Taste Test Questionnaire Used In In-House Sensory Evaluation Testing. (continued)

Figure 1. (continued)

		# _____	# _____
STRENGTH OF BERRY FLAVOR	Definitely too strong	/ /	/ /
	Slightly too strong	/ /	/ /
	Just right	/ /	/ /
	Slightly too weak	/ /	/ /
	Definitely too weak	/ /	/ /

		# _____	# _____
SOURNESS/ TARTNESS	Definitely too sour/tart	/ /	/ /
	Slightly too sour/tart		
	Just right	/ /	/ /
	Slightly not sour/tart enough	/ /	/ /
	Definitely not sour/tart enough	/ /	/ /

		# _____	# _____
CARBONATION	Definitely too carbonated	/ /	/ /
	Slightly too carbonated	/ /	/ /
	Just right	/ /	/ /
	Slightly not carbonated enough	/ /	/ /
	Definitely not carbonated enough	/ /	/ /

---

3. Which one do you prefer? (please check one.)

_____ / / # _____ / /

(continued)

Figure 1. (continued)

4. Please comment on why you preferred the wine you did. Please be as specific as possible.

_____

_____

_____

5. When was the last time you consumed wine of any kind? (please check one)

At least once within the past two weeks	/ /
At least once within the past month	/ /
At least once within the past three months	/ /
Less frequently	/ /
Never	/ /

6. When was the last time you consumed a "pop" wine? (please check one)

At least once within the past two weeks	/ /
At least once within the past month	/ /
At least once within the past three months	/ /
Less frequently	/ /
Never	/ /

7. If you consume "pop" wine, what flavor do you normally consume?

Thank You!

BERRY-FLAVORED WINE

INSTRUCTIONS: You will be asked to taste two samples of berry-flavored wine. The samples will be served one at a time. Taste the sample that is in front of you. Drink as much as you need to answer the following questions:

1. How much do you LIKE or DISLIKE this sample, EVERYTHING CONSIDERED? (Please check one.) #_____

- Like extremely..... ☐
- Like very much..... ☐
- Like moderately..... ☐
- Like slightly..... ☐
- Neither like nor dislike..... ☐
- Dislike slightly..... ☐
- Dislike moderately..... ☐
- Dislike very much..... ☐
- Dislike extremely..... ☐

2. How would you rate the SWEETNESS of this sample? (Please check one.)

- Definitely too sweet..... ☐
- Slightly too sweet..... ☐
- Just right..... ☐
- Slightly not sweet enough..... ☐
- Definitely not sweet enough..... ☐

Figure 2. Wine Taste Test Questionnaire Used In Consumer Sensory Evaluation Testing. (continued)

Figure 2. (continued)

3. How would you rate the STRENGTH OF BERRY FLAVOR of this sample? (Please check one.)

Definitely too strong..... ☐

Slightly too strong..... ☐

Just right..... ☐

Slightly too weak..... ☐

Definitely too weak..... ☐

4. How would you rate the TARTNESS of this sample? #_____
(Please check one.)

Definitely too tart..... ☐

Slightly too tart..... ☐

Just right..... ☐

Slightly not tart enough..... ☐

Definitely not tart enough..... ☐

5. How would you rate the CARBONATION of this sample? (Please check one.)

Definitely too carbonated..... ☐

Slightly too carbonated..... ☐

Just right..... ☐

Slightly not carbonated enough..... ☐

Definitely not carbonated enough..... ☐

****
* After you have completed these questions, please drink some water, *
* eat the cracker on your tray and wait a few minutes. When you are *
* ready to receive your second sample, please raise your hand. You *
* will then be served your second sample. *
****

Please turn page.....

Figure 2. (continued)

Now, please taste your second sample, drinking as much as you need to answer the following questions:

6. How much do you LIKE or DISLIKE this sample, EVERYTHING CONSIDERED? #_____

- Like extremely..... ☐
- Like very much..... ☐
- Like moderately..... ☐
- Like slightly..... ☐
- Neither like nor dislike..... ☐
- Dislike slightly..... ☐
- Dislike moderately..... ☐
- Dislike very much..... ☐
- Dislike extremely..... ☐

7. How would you rate the SWEETNESS of this sample? (Please check one.)

- Definitely too sweet..... ☐
- Slightly too sweet..... ☐
- Just right..... ☐
- Slightly not sweet enough..... ☐
- Definitely not sweet enough..... ☐

8. How would you rate the STRENGTH OF BERRY FLAVOR of this sample? (Please check one.)

- Definitely too strong..... ☐
- Slightly too strong..... ☐

Please turn page.....

Figure 2. (continued)

Just right..... ☐

Slightly too weak..... ☐

Definitely too weak..... ☐

9. How would you rate the TARTNESS of this sample? #_____
(Please check one.)

Definitely too tart..... ☐

Slightly too tart..... ☐

Just right..... ☐

Slightly not tart enough..... ☐

Definitely not tart enough..... ☐

10. How would you rate the CARBONATION of this sample? (Please check one.)

Definitely too carbonated..... ☐

Slightly too carbonated..... ☐

Just right..... ☐

Slightly not carbonated enough..... ☐

Definitely not carbonated enough..... ☐

11. Now that you have tasted both samples of berry-flavored wine, which ONE do you prefer? (Please check one.)

First sample tasted, #_____..... ☐

Second sample tasted, #_____..... ☐

12. Do you prefer that sample...?

A lot more than the other sample..... ☐

Please turn page.....

Figure 2. (continued)

A little more than the other sample..... ☐

About the same as the other sample..... ☐

13. Why do you prefer that sample. Please be as specific as possible.

_____ _____

_____

_____

THANK YOU FOR PARTICIPATING! Please leave your tray and turn in your questionnaire to the panel director upon leaving.

MARKETING RESEARCH

This test was a central location paired comparison test (Figure 3.) using FFWB and Annie Green Springs Berry Frost, the objectives being to determine consumer attitudes toward the FFWB, and a comparison to Annie Green Springs Berry Frost.

The test was conducted at three geographic locations during February, 1978. The three locations were Boston, Chicago and Los Angeles. The total of 468 respondents were stratified by color, sex, and age. All respondents were of legal drinking age and had personally consumed a "pop" wine within the month preceding the test.

In each test, approximately three ounces of each sample, chilled, were presented without brand identification, and the first sample served was systematically rotated to eliminate positional or order of tasting bias.

Respondents in the tests were asked to rate each product, using a nine point hedonic "like/dislike" scale of words as their best description of how they liked the product, all things considered. They were further asked to rate each product on the five attributes; color, strength of berry flavor, sweetness, effervescence, and tartness.

PRC #1443 WINE TASTE TEST QUESTIONNAIRE

Group _____

Rotation Order
Tried 1st _____
Tried 2nd _____

PRINT

Respondent Name: _____ Phone NO.: _____

Address: _____ City: _____

Interviewer: _____ Length of Interview: _____

Hello, I'M _____ from Parker Research Corporation. Today we're going to ask you some questions about wine.

1. Which of the following wine brands have you drunk within the past month? (READ LIST)

	Yes	No
T. J. Swann	☐	☐
Annie Green Springs	☐	☐
Boone's Farm	☐	☐
Ripple (red or white)	☐	☐

IF "YES" TO AT LEAST ONE OF ABOVE BRANDS, CONTINUE; IF "NO" TO ALL OF THE ABOVE BRANDS, TERMINATE.

2. Does anyone in your immediate household work for a food company, an advertising agency, a good manufacturer or a food broker?

Yes...☐ (TERMINATE) No...☐ (CONTINUE)

3. Have you participated in a taste test within the past 6 months?

Yes..☐ (TERMINATE) No...☐ (CONTINUE)

4. Would your age be under 21, 21-25, 26-30, 31-35 or over 35 years?

Under 21	☐ (TERMINATE)
21 - 25	☐ (CONTINUE)
26 - 30	☐ (CONTINUE)
31 - 35	☐ (CONTINUE)
Over 35	☐ (TERMINATE)

Figure 3. Wine Taste Test Questionnaire Used in Marketing Central Location Research Testing. (continued)

Figure 3. (continued)

ESCORT RESPONDENT TO TASTING AREA.

You will be asked to taste two samples of berry flavored wine. The samples will be served one at a time.

HAND RESPONDENT FIRST SAMPLE INDICATED AT THE TOP OF THE QUESTIONNAIRE.

5. I'd like for you to taste this sample of wine. First, please take a bit of cracker and a drink of water. Please drink as much of the sample as you need to form an opinion.

(HAND RESPONDENT "RATING" CARD.) All things considered, which statement on this card best describes how much you like or dislike this product?

Like extremely..... ☐
Like it very much..... ☐
Like it moderately..... ☐
Like it slightly..... ☐
Neither like nor dislike it..... ☐
Dislike it slightly..... ☐
Dislike it moderately..... ☐
Dislike it very much..... ☐
Dislike it extremely..... ☐

6. How would you rate the color? (READ CHOICE)

Too light..... ☐
Just right..... ☐
Too dark..... ☐

7. How would you rate the strength of the berry flavor? (READ CHOICES)

Too strong..... ☐
Just right..... ☐
Not strong enough..... ☐

8. How would you rate this product on sweetness? (READ CHOICES)

Too sweet..... ☐
Just right..... ☐
Not sweet enough..... ☐

9. How would you rate the carbonation of this product? (READ CHOICES)

Too much carbonation..... ☐
Just right..... ☐
Not enough carbonation..... ☐

(continued)

Figure 3. (continued)

10. How would you rate the tartness of this product? (READ CHOICES)

Too tart..... ☐
Just right..... ☐
Not tart enough..... ☐

11a. Was there anything about this product that you dislike?

Yes... ☐ (ASK Q. 11b.) No... ☐ (SKIP TO Q.12)

11b. (IF "YES" TO Q. 11a, ASK:) What did you dislike? (PROBE)

_____

_____

_____

(continued

Figure 3. (continued)

REMOVE FIRST SAMPLE.

HAND RESPONDENT SECOND SAMPLE.

12. Now I'd like for you to taste another sample of wine. First, please take a bite of cracker and drink of water. Please drink as much of the sample as you need to form an opinion.

(HAND RESPONDENT "RATING"CARD.) All things considered, which statement on this card best describes how much you like or dislike this product?

Like it extremely..... ☐
Like it very much..... ☐
Like it moderately..... ☐
Like it slightly..... ☐
Neither like nor dislike it..... ☐
Dislike it slightly..... ☐
Dislike it moderately..... ☐
Dislike it very much..... ☐
Dislike it extremely..... ☐

13. How would you rate the color? (READ CHOICES)

Too light..... ☐
Just right..... ☐
Too dark..... ☐

14. How would you rate the strength of the berry flavor? (READ CHOICES)

Too strong..... ☐
Just right..... ☐
Not strong enough..... ☐

15. How would you rate this product on sweetness? (READ CHOICES)

Too sweet..... ☐
Just right..... ☐
Not sweet enough..... ☐

16. How would you rate the carbonation of this product? (READ CHOICES)

Too much carbonation..... ☐
Just right..... ☐
Not enough carbonation..... ☐

(continued)

Figure 3. (continued)

17. How would you rate the tartness of this product? (READ CHOICES)

Too tart..... ☐
Just right..... ☐
Not tart enough..... ☐

18a. Was there anything about this product that you dislike?

Yes... ☐ (ASK Q. 18b) No... ☐ (SKIP TO Q.19)

18b. (IF "YES" TO Q. 18a, ASK:) What did you dislike? (PROBE)

_____

_____

_____

19a. Now that you've tasted both products, did you notice any difference between the two products?

Yes... ☐ (ASK Q. 19b) No... ☐ (SKIP TO Q. 20)

19b. What was the difference between the two products? (PROBE FOR PARTICULAR PRODUCT.)

_____

_____

_____

20. Now that you have tasted both products, which one do you prefer?

Product Tried First #_____..... ☐
Product Tried Second #_____..... ☐

21. Do you prefer that product....(READ CHOICES)

A lot more than the other product..... ☐
A little more than the other product.. ☐
About the same as the other product... ☐

22. Why did you prefer that product? (PROBE AND IDENTIFY PRODUCT NUMBER REFERRED TO.)

_____

_____

_____

THANK YOU FOR YOUR COOPERATION!

SECTION VI

PROCESS DEVELOPMENT

CONFIRMING OREGON STATE UNIVERSITY BENCHTOP RESULTS

The thrust of this confirmation study was to demonstrate a direct transfer of the fermentation of supplemented whey by a wine yeast from benchtop scale to semi-production scale using commercial dairy and cheese plant equipment wherever possible.

Jack cheese whey was procured from a local source at about pH 6.0. The residual milk fat was removed by processing through a milk separator and 1,100 liters of the clarified whey was supplemented with 22 percent added dextrose and 100ppm sulfur dioxide from potassium metabisulfite, and placed in a 1,500 liter stainless steel vertical dairy processing tank with slow sweep agitator and stainless steel cover. It was cooled to 21°C using water on the jacket.

Active dry Montrachet Wine Yeast was added at a rate of 12 grams per 54 kilograms of supplemented whey, and the agitator was started to disperse and suspend the yeast. The temperature in the tank was maintained at 20°-22°C and agitation was continued until active fermentation began (about a day) at which time mechanical agitation was stopped, the fermentation action providing its own agitation to completion.

The fermentation was monitored by reduction of refractometer solids and was essentially complete within 7-8 days as shown by no change in refractometer solids on two succeeding days. At this time, alcohol was determined to be between nine and ten percent by volume.

No special sanitary precautions were taken during this test. The whey was pasteurized; the separator, product lines and fermentation tank were cleaned and sanitized in accordance with good dairy plant practice and the tank cover was in place during the course of fermentation.

In view of the procedures and the results, OSU technology had been satisfactorily transferred to semi-commercial scale.

DEPROTEINIZATION

OSU had demonstrated preparing whey for fermentation into a clear beverage by heat denaturation of the heat labile portion of whey protein followed by

separation. This was tested on 1,100 liter batch of jack cheese whey by heating to 185°F through a tubular heater into a 1,500 liter tank, followed by cooling to less than 6°C and holding for sedimentation without agitation. Twenty-four hour holding resulted in incomplete separation of the denatured protein resulting in a cloudy fermentation medium. Clarification by centrifugal means (a dairy clarifier) failed to improve the clarity significantly.

In another experiment, chemical treatment, using sodium pyrophosphate and calcium chloride, followed by heating to 90°C for 15 minutes then cooling, gave better results; but still unsatisfactory insofar as protein removal was concerned.

A third approach to deproteinization of whey yielded a water clear permeate (Table 2) for fermentation and a protein rich WPC by-product composed of undenatured whey protein (highly functional and nutritious) with other whey constituents. This approach utilized ultrafiltration (UF). Ultrafiltration is a process in commercial use by the whey industry and others, to partition low molecular weight components (as lactose, minerals, water) from high molecular weight components (as protein) by means of selective and designed porosity of a semi-permeable membrane.

In simple practice, whey is pumped through a semi-permeable membrane system under pressure, and part of the water, minerals, nonprotein nitrogen and lactose (milk sugar) pass through the membrane walls into a receiving vessel while the protein, composed of large molecules, is retained in the system together with the remaining permeable materials.

The amount of permeate separated, and the concentration of the protein in the whey retained, are dependent upon many factors. Suffice it to say, that concentration of protein to 50 percent on a moisture free basis is practically accomplished by several commercial UF systems available in a variety of sizes. This normally results in about 90 percent of the original whey being passed as permeate for fermentation.

One added process step may or may not be required for deproteinization of whey by UF; centrifugal clarification and separation. This pretreatment step, prior to UF, was included in the study because other experience (not reported here) has shown that fine curds in cottage cheese whey and milk fat remaining in sweet cheese wheys can interfere with trouble free operation of UF systems, by coating or plugging the membranes, limiting the duration of the UF operation and requiring excessive cleaning of the membranes to restore optimum operability.

The by-product of UF, the protein rich concentrate, is an article of commerce in the dried form and is currently recycled (together with the waste removed by the clarifier/separator pre-treatment) into the cheese making operation or into other dairy products. It has, therefore, the true connotation of a by-product instead of a waste product. As a last resort, it can be recycled to the dairy operation as an animal feed supplement.

TABLE 2. ANALYSIS OF PERMEATE

From Cottage Cheese and Sweet Whey

	Cottage Cheese Whey		Sweet Whey	
	(Liquid, %)	(Dry Basis, %)	(Liquid, %)	(Dry Basis, %)
Total Solids	5.71	97.25	5.70	97.25
Acid	0.46	8.06	0.25	4.37
Total Nitrogen	0.041	0.718	0.049	0.858
NPN	0.037	0.648	0.02	0.35
Total N. as protein (x 6.38)	0.264	4.62	0.25	4.40
Ash	0.706	12.36	0.55	9.60
Fat	0.0024	0.042	0.001	0.018
Lactose	4.22	73.86	4.86	85.0
Calcium	0.109	1.91	0.099	1.73
Phosphorus	0.073	1.28	0.154	0.95
Sodium	0.037	0.71	0.055	0.96
Potassium	0.141	2.47	0.119	2.05
pH	4.5	4.5	6.0-6.3	6.0-6.3

SUPPLEMENTATION OF THE PERMEATE

Permeate consists of water containing lactose, milk minerals, nonprotein nitrogen and miscellaneous vitamins and other materials from cows milk. The lactose is a sugar, but it is not fermented by the Montrachet wine yeast selected for this study; nor in fact by any other wine yeast. To ferment the lactose into alcohol requires a specialized yeast type, a longer fermentation and results in a yield only about two percent alcohol, if completely fermented. Thus, the processing would require further supplementation with lactose to derive a ferment containing the necessary 8-10 percent alcohol.

Lactose is an expensive sugar as compared to other available and fermentable sugars. All things being considered, supplementation of permeate with lactose for fermentation by a nonwine yeast was rejected as costly, slow and requiring microbial technology beyond that normally available in a cheese plant environment. Alternatively, to supplement permeate with sugar fermentable by the Montrachet yeast was selected as the route of choice, leaving the lactose intact to provide some sweetness and other flavor notes to the finished product.

OSU supplementation technology was adapted to this study and was not further researched. It consists of adding 22 percent dextrose to permeate as a fermentable carbohydrate and 100 parts per million (ppm) sulfur dioxide in the form of potassium metabisulfite as a preservative and flavor adjunct in the finished product.

FERMENTATION

As in the case of permeate supplementation, OSU technology for fermentation was transferred almost directly without further research, and was unchanged throughout the study. This involved inoculating the supplemented permeate with 0.02 percent Montrachet wine yeast by weight and fermenting at 20°-22°C until the refractometer solids remained relatively constant for a day, at which time the fermentation was considered complete (Table 3).

Fermentation was conducted many times during the course of the study, with sweet cheese whey permeates and cottage cheese whey permeates as the raw materials. No difficulty in fermentation was noted (except in one experiment to be reported in the subsection titled Demineralization) and no extraneous microbial growth was found. The fermentations were all complete within a period of seven to ten days, and no atypical ferments were discovered.

REMOVAL OF YEAST BIOMASS

Following fermentation, removal of the yeast cells added to and formed in the fermentation is required to provide a clear FWB. This step can be accomplished by sedimentation in the fermentation tank followed by decantation. However, this is costly in time, requiring several days to complete the sedimentation, and is relatively incomplete, requiring addition of fining agents (bentonite) and further sedimentation or "racking" to provide a clear FWB.

TABLE 3. REFRACTOMETER SOLIDS AND pH MEASUREMENTS WITH TIME SHOWING THE COURSE OF NORMAL FERMENTATION OF PERMEATE

Fermentation Time Days	Refractometer Solids %	pH
0	20	6.1
1	20.1	5.4
2	18.6	4.6
3	-	-
4	-	-
5	14.6	3.6
6	12.0	3.2
7	10.3	3.1
8	9.0	3.1
9	8.6	3.3
10	-	-
11	9.0	3.1
12	8.6	3.3

Two other methods consistent with dairy or cheese plant operations were tested, and both were found speedy and efficient. These are centrifugal separation and filtration.

Centrifugal separation using a dairy clarifier resulted in a clear FWB and a concentrate of yeast cells and other fermentation debris; pressure filtration using a plate and frame filter press with diatomaceous earth filter aid resulted in a clear FWB and a filter cake containing the yeast and fermentation debris in a matrix of filter aid.

Experience with both sweet and acid whey fermentations showed that between 1.5 and 4.5 percent of the ferment weight was removed by either of the separation technics, leaving 95.5 - 98.5 percent of the weights as clarified ferment.

Either of the by-products (clarifier concentrate or filter cake) is suitable for dairy feed supplementation and can be disposed of in that manner at no cost. In the event that other disposal is required, the clarifier concentrate can be cycled to wastewater treatment and the filter cake to sanitary land fills. In either case the COD -- as compared to that of the whey from which it came -- is low.

DEMINERALIZATION

Demineralization of fermented permeates was discovered to be a necessary process step to yield FWB that was not too salty to be considered palatable, either in the native FWB form or in flavored versions.

Two methods of demineralization were explored, and each performed satisfactorily to reduce the salty taste to levels below sensory detection in the FWB base. Both are commercially used — ion exchange (IE) in purification of brackish waters for potable uses and electrodialysis (ED) in demineralization of whey for modified whey product manufacture.

Exploring ion exchange, a system was configured of two resin beds, the first being a strong acid cation exchanger (Chempro C25) and the second a weak base deacidifier (Chempro A6). Both of the resins are commercially used by the starch reduction industry to demineralize corn syrups. The operation, as carried out in this study, consists of passing the FWB through the cation exchanger bed to convert the mineral salts to acids, and then through the deacidifier bed to adsorb the acid, resulting in a more or less neutral FWB with 90% or more of the mineral salts removed.

Testing this procedure on jack cheese whey fermented into FWB base, and comparing it to the undemineralized FWB base, it was found that the IE treatment had reduced the bitterness and markedly reduced the saltiness; and further, had removed the whey flavor notes, providing a much cleaner tasting FWB for flavoring.

Considering that IE prior to fermentation might be preferred to IE after fermentation, a test was set up wherein the clarified permeate was subjected to the IE treatment prior to supplementation. Upon inoculation of the

supplemented IE permeate with Montrachet yeast and incubation, fermentation failed to occur (Table 4.), until whole whey was added. Testing whether or not this was the result of some unknown factor or the IE processing, the IE of clarified permeate was repeated and following supplementation and inoculation with the Montrachet yeast, the batch was split into several small portions.

To one portion, the control, nothing was added. To other portions quantities of the varied milk minerals native to the permeate were added back. To yet another, a combination of milk minerals plus an inorganic nitrogen source were added.

Upon incubation it became clear that the IE process had depleted the permeate of essential nutrients: although the control again failed to ferment satisfactorily and the portions with mineral salts only marginally better, the portion supplemented with the combination of milk mineral salts plus the nitrogen source fermented normally (Table 5.). These results made it amply clear the IE must be performed after fermentation.

It was adviseable to test the second method of demineralizing, and compare the results in the FWB. Electrodialysis, in contrast, to IE, can be operated to affect any degree of demineralization in whey from 25 to 90 percent.

Testing whether ED prior to fermentation had the same inhibitory effect as IE, a series of ED permeates were made at varying degrees of demineralization from zero to 90% mineral removal. Those were supplemented, inoculated and incubated in the normal fashion. The results showed that fermentations were normal in all cases up to 86% removal of minerals; the one case showing inhibition being at 90% removal of minerals. In the latter case fermentation did occur, but slowly, and was not yet complete at 12 days, whereas the others were essentially finished at 7 days (Table 6.).

Tasting the FWB ferments, using the project team members as an informal panel, it was agreed that 50% removal of minerals from the permeate reduced the saltiness to a satisfactory level as compared to IE FWB.

It appeared that two optional points in processing would permit ED demineralization. Testing whether ED prior to fermentation was in any sense different from ED after fermentation, the informal panel tested FWB made by each process from a common lot of whey and agreed that they were essentially the same.

To compare ion exchange with electrodialysis as demineralizing methods, FWB from mozzarella cheese whey was split, processed by each route and the products compared (both base and flavored) by preference/acceptance testing. Results indicated that IE produced a somewhat cleaner (less whey flavor) FWB base then did ED to fifty percent mineral removal, while the reverse seemed to be true for the flavored versions (Tables 7. and 8.). However, the differences were slight and in summary it was agreed that flavoring system adjustment could make the two demineralizing processes optionally equivalent. The flavored versions were made from the base versions by adding a Black Currant With Other Natural Flavors (BC WONF) flavor concentrate, sweetening with 50% invert syrup and carbonating to about two volumes of carbon dioxide. No attempt was made at this time to optimize the flavoring system to achieve

TABLE 4. REFRACTOMETER SOLIDS AND pH MEASUREMENTS WITH TIME SHOWING LACK OF FERMENTATION IN IE PERMEATE, AND FERMENTATION FOLLOWING SUPPLEMENTATION WITH WHOLE WHEY

Fermentation Time Days		Refractometer Solids %	pH
0		20.5	-
1		20.5	4.55
2		20.5	4.3
3		20.5	4.4
4		21.0	4.4
5	Whey added	20.5	4.3
6		20.5	4.6
7		-	-
8		-	-
9		15.8	4.2
10		13.9	4.1
11		12.8	4.0
12		11.5	4.1
13		11.4	3.9
14		-	-
15		11.4	4.1
16			

TABLE 5. REFRACTOMETER SOLIDS AND pH MEASUREMENTS WITH TIME SHOWING EFFECTS OF ADDED SUPPLEMENTS TO IE PERMEATE ON FERMENTATION RATES

Fermentation Time Days	IE Permeate Control		IE Permeate Plus Minerals		IE Permeate Plus Minerals Plus NH_3	
	RS* %	pH	RS %	pH	RS %	pH
0	20.1	4.2	20.0	5.7	20.0	6.1
1	20.0	4.1	20.1	5.4	20.1	5.4
2	20.0	4.3	19.3	4.9	18.5	4.6
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	18.9	3.9	18.1	4.2	14.4	3.6
6	18.5	3.8	17.4	4.1	12.0	3.2
7	18.0	3.7	16.5	3.9	10.3	3.1
8	17.7	3.6	15.8	3.9	9.0	3.1
9	17.5	3.6	15.2	3.9	8.6	3.3
10	-	-	-	-	-	-
11	17.2	3.4	14.1	3.6	-	-
12	16.4	3.5	13.3	3.7	-	-
13	15.9	3.4	12.8	3.6	-	-
14	14.7	3.5	12.0	3.6	-	-
15	15.0	3.6	11.2	3.7	-	-
16	-	-	-	-	-	-
17	-	-	-	-	-	-
18	13.8	3.5	9.6	3.6	-	-
19	-	-	-	-	-	-
20	12.5	3.3	9.1	3.6	-	-
21	-	-	-	-	-	-
22	11.6	3.6	8.8	3.8	-	-

* Refractometer solids

TABLE 6. REFRACTOMETER SOLIDS AND TITRATABLE ACIDITY MEASUREMENTS WITH TIME SHOWING EFFECT OF PERCENT DEMINERALIZATION OF PERMEATE BY ED ON FERMENTATION RATES

	Percent Demineralization of Permeate									
	0		52		74		86		90	
Fermentation Days	RS[1/] %	TA[2/] %	RS %	TA %	RS %	TA %	RS %	TA %	RS %	TA %
0	21.0	.34	20.6	.30	20.6	.25	20.9	.22	20.8	.07
1	17.8	.43	17.0	.38	18.0	.38	18.0	.29	20.6	.12
2	15.4	.53	15.0	.52	15.9	.45	16.4	.41	20.2	.17
3	-	-	-	-	-	-	-	-	-	-
4	13.1	.59	12.3	.54	12.8	.47	13.4	.44	19.3	.22
5	-	-	-	-	-	-	-	-	-	-
6	10.5	.54	10.4	.54	11.1	.45	11.0	.46	18.8	.33
7	10.0	.62	9.6	.54	10.0	.48	10.1	.48	17.6	.32
8	-	-	-	-	-	-	-	-	-	-
9	9.3	.63	9.1	.52	9.0	.49	9.0	.48	16.0	.31
10	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-
12	9.5	.50	8.9	.45	10.1	.51	9.0	.42	13.0	.41

1/ Refractometer solids

2/ Titratable acidity

TABLE 7. SENSORY EVALUATION REPORT SHOWING COMPARABILITYOF ELECTRODIALYSED ED FFWB AND IE ION EXCHANGED FFWB IN TERMS OF OVERALL AND PREFERENCE RATINGS

A Percentage Distribution of OVERALL Ratings for Wine

		#994E277A(IE) vs. #994E277E(ED) N=31			
Like extremely	9	(0)	0%	(0)	0%
Like very much	8	(1)	3	(5)	16
SUBTOTAL		(1)	3%	(5)	16%
Like moderately	7	(7)	23	(7)	23
Like slightly	6	(8)	26	(9)	29
Neither like nor dislike	5	(5)	16	(1)	3
Dislike slightly	4	(4)	13	(6)	19
Dislike moderately	3	(2)	6	(3)	10
Dislike very much	2	(3)	10	(0)	0
Dislike extremely	1	(1)	3	(0)	0
TOTAL			100%		100%
Mean rating			5.1		5.8

Statistical analysis was done using Student's t-Test. However, no significant difference was found.

A Percentage Distribution of PREFERENCE Ratings

	N=31	
#994277A(IE)	(15)	48%
#994277B(ED)	(15)	48
No Preference	(1)	4
TOTAL		100%

TABLE 8. SENSORY EVALUATION REPORT SHOWING COMPARABILITY OF ELECTRODIALYSED FFWB AND ION EXCHANGED FFWB IN TERMS OF ATTRIBUTE RATINGS

A Percentage Distribution of ATTRIBUTE ratings for Wine

		#994E277A(IE) vs #994E27B(ED) N=31			
SWEETNESS					
Definitely too sweet	5	(3)	10%	(3)	10%
Slightly too sweet	4	(7)	3	(5)	16
Just right	3	(13)	41	(18)	58
Slightly not sweet enough	2	(8)	26	(5)	16
Definitely not sweet enough	1	(0)	0	(0)	0
TOTAL			100%		100%
Mean rating			3.2		3.2
STRENGTH OF BERRY FLAVOR					
Definitely too strong	5	(1)	3%	(2)	6%
Slightly too strong	4	(5)	16	(1)	3
Just right	3	(14)	45	(15)	49
Slightly too weak	2	(8)	26	(10)	32
Definitely too weak	1	(3)	10	(3)	10
TOTAL			100%		100%
Mean rating			2.8		2.8
SOURNESS/TARTNESS					
Definitely sour/tart	5	(4)	13%	(0)	0%
Slightly too sour/tart	4	(6)	19	(10)	33
Just right	3	(16)	52	(13)	42
Slightly not sour/tart enough	2	(4)	13	(6)	19
Definitely not sour/tart enough	1	(1)	3	(1)	3
No answer		(0)	0	(1)	3
TOTAL			100%		100%
Mean rating			3.3		3.1

TABLE 8. (continued)

A Percentage Distribution of ATTRIBUTE Ratings for Wine

CARBONATION					
Definitely too carbonated	5	(1)	3%	(0)	0%
Slightly too carbonated	4	(6)	19	(5)	16
Just right	3	(19)	62	(20)	65
Slightly not carbonated enough	2	(4)	13	(3)	10
Definitely not carbonated enough	1	(1)	3	(2)	6
No answer		(0)	0	(1)	3
TOTAL			100%		100%
Mean rating			3.1		2.9

Statistical analysis was done using Student's t-Test. However, no significant difference was found.

the most pleasing balance of flavor and sweetness, nor were any efforts expended to optimize removal of sediment and haze contributed by the flavor concentrate.

POLISHING FILTRATION

To make a sparkling clear beverage from the flavored FWB required removal of sediment contributed by the BC WONF flavor concentrate. It was found that on some occasions filtration through an 0.45 micron filter preceded by a fibrous prefilter was satisfactory, but on other occasions the filtration rate was so slow that prefiltration through a plate and frame filter with the help of a small amount of diatomaceous earth filter aid was a definite advantage.

In either case, the 0.45 micron membrane filter performed satisfactorily in terms of removing haze components and residual yeast cell matter and providing a sparkling clear beverage for carbonation and bottling.

CARBONATION

Samples of the commercial target wine were tested for carbonation level and found to vary somewhat from bottle to bottle. Overall, the level appeared to be in the range of 1.8 - 2.0 volumes of carbon dioxide.

A flavored FWB product (FFWB) was carbonated to 1.7, 2.1, 2.5 and 2.9 volumes and tested against the target wine for perceived carbonation level. The results indicated that a level between 1.7 and 1.9 volumes of carbon dioxide in the FFWB was perceived to be the same as the target wine. Consequently, 1.8 volumes of carbon dioxide was selected as our product target.

SECTION VII

PROCESS FLOW AND MATERIAL BALANCES

Process flow charts, projected to 4,000 liter ferments based on experience with 1,135 liter ferments, are presented in Figures 4. and 5. for acid whey and sweet whey respectively.

Comparing the two flow charts points out that a greater input of chemical regenerants is required to demineralize the acid whey FWB than to demineralize the sweet whey FWB. This in part can be explained by the greater content of organic acid in the acid whey which requires a greater volume of the deacidifying resin component per unit volume of FWB to satisfactorily remove the minerals.

The material balances as presented in the flow charts are exemplary, based on experience with single sources of whey used in this study. Variations in the cheesemaking process from plant to plant, day to day and month to month, as well as changes in the whey due to seasonal variations in the milk supply and geographic location will all bear on the material balances found in practice.

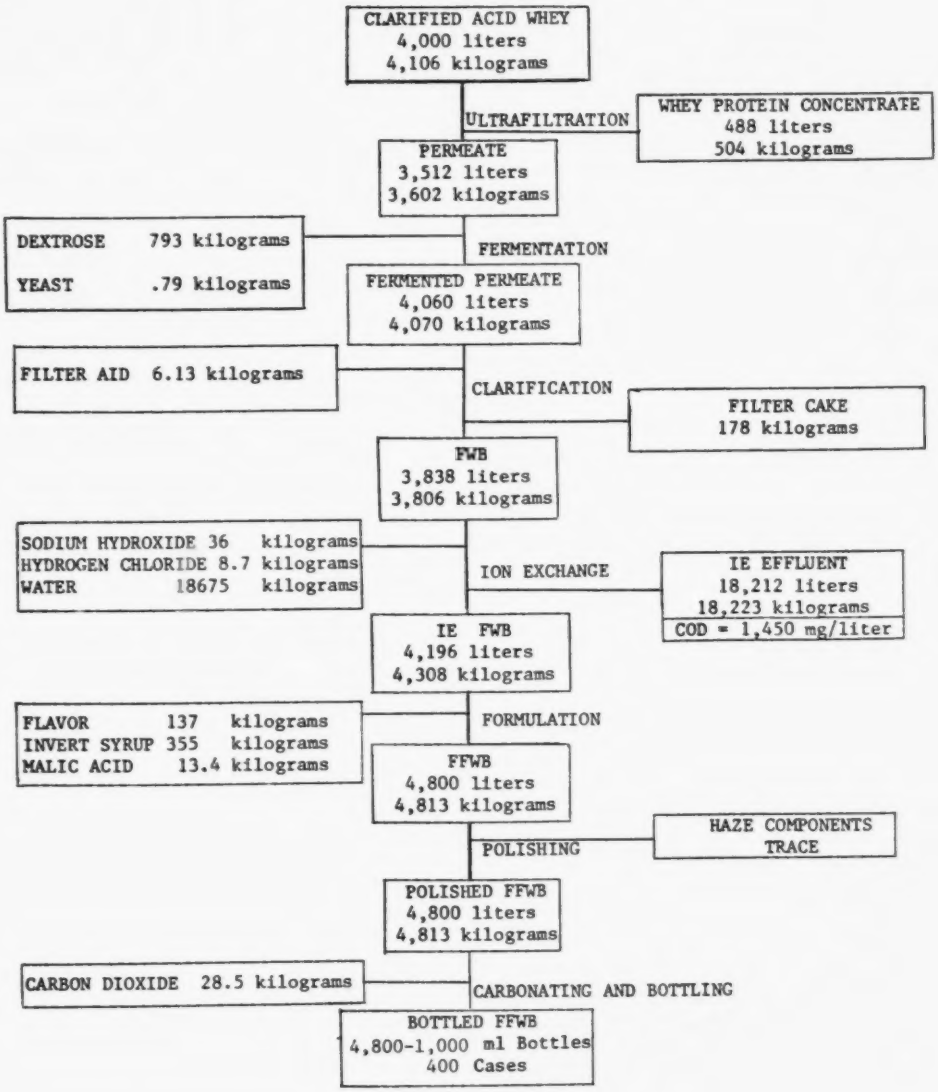

Figure 4. Process flow diagram for FFWB from acid whey.

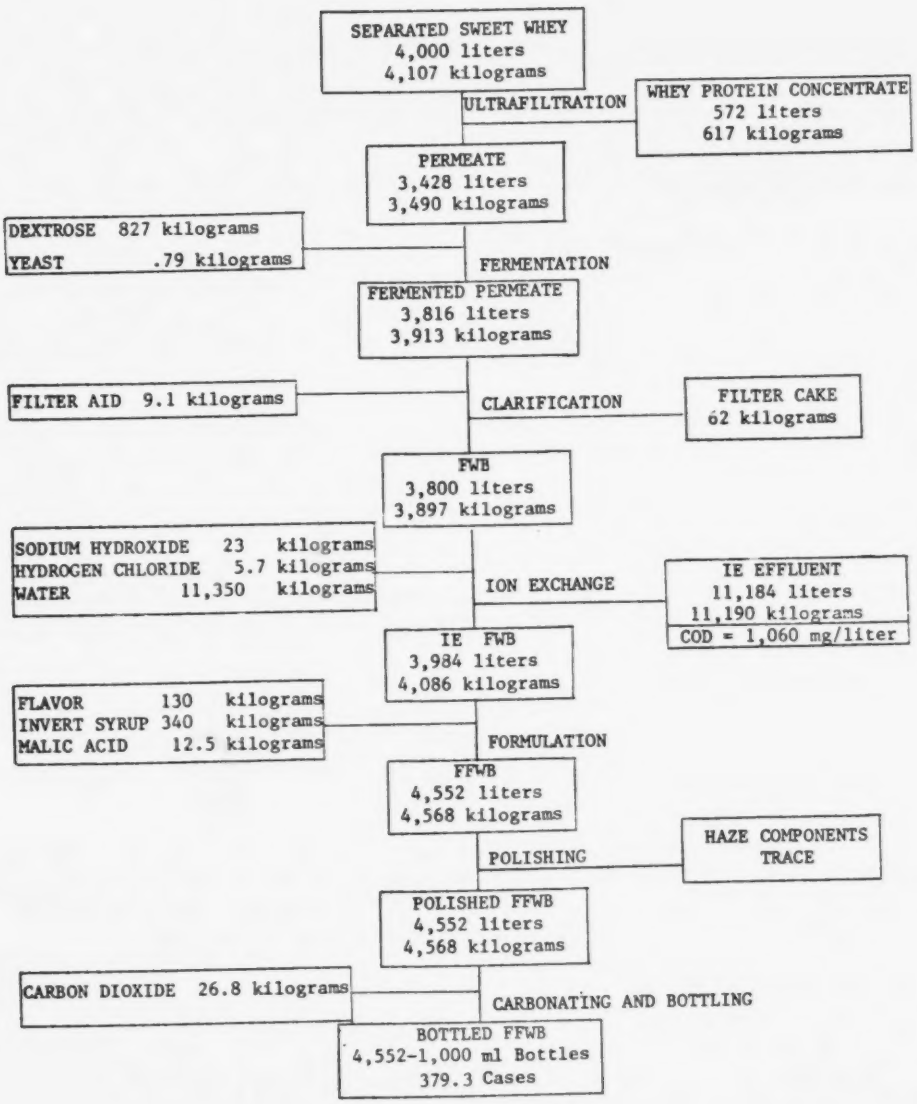

Figure 5. Process flow diagram for FFWB from sweet whey.

SECTION VIII

FLAVORED FWB (FFWB) DEVELOPMENT

SELECTING THE TARGET WINE

Selection of a target flavored wine to compete with in demonstrating parity acceptance of FWB with commercial product by consumers was accomplished relatively early in the study. The prime criteria set up in advance, were that the target wine must be a market leader in the flavored wine class, and that it must be a fruit flavored wine.

To select the market leaders, we consulted available sales volume reports and selected three fruit flavored wines which showed the greatest sales record at that time, and a fourth which had a steep growth curve, but was a relative newcomer. The flavors of the select group included berry, plum, peach, and strawberry.

An informal panel of project team members was assembled to select, from that group, the kind of flavor we thought would be most compatible with FWB, and set that as our target.

The strawberry flavored wine was rejected based on its semi-artificial flavor, and difficult past experiences with strawberry flavors in other food and beverage applications. The peach flavored wine was rejected as being clearly a nonpeach flavor, in the opinion of the panel.

A currant flavored wine, Annie Green Spring (AGS) Berry Frost TM, was selected as our prime target. It is identified as being composed of grape wine and natural currant and other natural flavors. As a backup, and a parallel target in preliminary studies, AGS Plum Hollow TM was selected.

SELECTING THE FLAVOR SYSTEM

To elicit a series of flavor concentrates to test in FWB, several flavor suppliers were provided with quantities of ion exchanged FWB and the two target wines purchased at the local supermarket. They were asked to respond with flavor concentrates compatible with the FWB and similar to the target wines in flavor and balance.

The response provided us with several flavor concentrates from a number of suppliers. These were screened by the informal panel by adding to the FWB, roughly balancing sweetness and carbonation and testing chilled.

Two "berry" flavored concentrates and one "plum" concentrate were first selected. They were prepared as FFWB's and compared with the representatively flavored target wines by a panel of thirty or more R&D people. In all cases, the commercial wine was preferred to the FFWB.

Based on the results of that study (comments) and further informal panel testing, the three acceptable concentrates were reduced to two by the elimination of one "berry" concentrate. Following this, DFA profiles were developed for both target wines and FFWB's based on ion exchanged jack cheese FWB with the two remaining concentrates. Based on the study and the summary evaluations indicating that the "berry" flavored FWB more closely matched its target wine in flavor profile than did the "plum" version, the "berry" flavored concentrate was selected, and the target became AGS Berry Frost.

DEVELOPING THE FLAVORING SYSTEM

The selected flavor concentrate was characterized as Black Currant With Other Natural Flavors (BC WONF). During the course of the study, as processing of the FWB was adjusted, the flavoring system was modified twice, to achieve the best processing and flavor balance compatible with the FWB at that time.

By the time the final IE or ED version of the FWB was developed, it became apparent that, particularly in the case of the IE version, increased acidity was required to round out the flavor system.

Several levels of lactic, citric and malic acid were tested and malic acid was selected at about 0.3 percent level as optimizing the flavor system and giving the cleanest flavored FWB.

The BC WONF concentrate was tested at various levels, as was sweetening with 50% invert syrup to give the most pleasing balance to the flavored FWB.

During the flavor system development, it became apparent that the BC WONF concentrate developed a precipitate in the FFWB on standing, even though it had been polished through the 0.45 micron membrane filter to sparkling clarity. Reporting this to the flavor concentrate manufacturer resulted in submission of a second generation system, essentially the same in flavor as the first, but with markedly reduced precipitation in the finished beverage.

As the flavor system development moved with the process development, a third version of BC WONF was provided, which had a brighter berry flavor and was perceived by the preference/acceptance panels as more closely approximating in like/dislike terms the target wine.

The final flavor system, which was used in the consumer test against the target wine, was added as follows to an IE version of cottage cheese permeate FWB:

- 50 percent invert syrup at 77% total solids — 8.25% W/V
- version 3 of BC WONF concentrate — 3.18% V/V
- malic acid — 0.31% W/V

- purified water sufficient to adjust alcohol 8.0% V/V
- carbonation to 1.8 - 2.0 volumes

SECTION IX

SENSORY EVALUATION

DESCRIPTIVE FLAVOR ANALYSIS

This method (described in Appendix A) of flavor analysis was used on nine key occasions throughout the study to establish aroma and flavor-by-mouth profiles of target wine(s) and developing FFWB's and to quantify specific sensory differences between the targets and experimental FFWB's.

It proved of great value in helping to direct development efforts, both of the FWB and the flavored versions, toward a beverage that in the end was to demonstrate parity acceptance with AGS Berry Frost in a selected market.

PARIED COMPARISON PREFERENCE TESTS

This method of sensory analysis was used on sixteen occasions with R&D panels and twice with selected consumers. Again, this proved of great value in pointing out consumer responses to the developing FFWB in comparison to the target wine.

APPLICATIONS TO PROCESS DEVELOPMENT

Sensory evaluation was the key response leading to the following conclusions during process development:

1. Demineralization of FWB was required to remove salty taste to satisfactorily develop FFWB.

2. Electrodialysis (50% or greater) was comparable in removal of salty taste to ion exchange.

3. Demineralized sweet whey FWB's (from jack or mozzarella whey) or demineralized acid whey (from cottage cheese) were equivalent as bases for flavoring into beverages.

4. Ion exchanged FWB required greater supplementation with (malic) acid to equal supplemented electrodialysed for flavoring into fruit flavored beverage.

SECTION X

ECONOMIC EVALUATION

Projecting to commercial production from pilot experience, the direct cost of manufacturing flavored fermented whey beverage into one liter wine bottles is:

- $0.98 per bottle for 3,785 liter per day plant or,
- $0.69 per bottle for 378,500 liter per day plant.

Of these costs, processing accounts for 19 percent; formulating and carbonating for 39 percent; and bottling and capping for 42 percent.

Taking credit for whey protein concentrate as a replacement for nonfat milk (at $0.75 per pound solids); sewering the IE effluents only, and taking credit for reduced sewerage cost (at $1.10/kilogram COD); and routing the filter cake to a garbage dump reduces the net costs to:

- $0.92 per bottle for 3,785 liter per day plant or,
- $0.63 per bottle for 378,500 liter per day plant.

Table 9. presents summary of costs for FFWB for 3,785 liter per day and 378,500 liter per day plants, and Appendix B presents the details of that summary.

TABLE 9. SUMMARY OF PROCESSING/BOTTLING COSTS FOR FFWB PRODUCT

COSTS ELEMENTS	Costs per Liter Finished Product 3,785 liters FWB BASE/DAY	378,500 liters FWB BASE/DAY
I. Processing		
Separation	$0.0056	$0.00024
Ultrafiltration	0.0119	0.0013
Fermentation	0.1368	0.1227
Ingredients	0.0873	0.0873
Process	0.0495	0.0354
Clarification	0.0056	0.00024
Filtration	0.0111	0.00024
Deashing	0.0146	0.0027
Ion Exchange	0.0146	0.0054
Electrodialysis	0.0182	0.0027
Processing Subtotal	$0.1856	$0.1275
II. Formulation Costs		
Flavoring	$0.1211	$0.0969
Invert Syrup	0.2094	0.1468
Malic Acid	0.0386	0.0275
Formulation Subtotal	$0.3691	$0.2712
III. Carbonation Costs		
Carbon Dioxide	$0.0059	$0.0006
Process	0.0149	0.0004
Carbonation Subtotal	$0.0208	$0.0010
IV. Bottling Cost		
Bottles	$0.2527	$0.1969
Caps	0.0134	0.0112
Process	0.1397	0.0847
Bottling Subtotal	$0.4058	$0.2928
Direct COSTS per LITER FINISHED PRODUCT	$0.9813	$0.6925
Savings in sewerage treatment costs	$0.0299	$0.0299
Credit for WPC at $1.65 per kg. solids	0.0301	0.0301
Net cost per liter bottle finished product	$0.9213	$0.6325

SECTION XI

MARKETING RESEARCH

Parker Research Corporation, South Pasedena, California, was commissioned to do the Market Research study to compare flavored FWB with Berry Frost in terms of acceptance.

Their conclusions from the study were reported:

1. In terms of both the levels of strong, positive response, as well as the mean ratings, there were no significant differences between the FFWB and the commercial target wine.

2. The flavor strength and tartness of whey wine was, essentially, acceptable. However, whey wine was generally considered to be "too light" in color and "too sweet". There was also a slight indication that whey wine was somewhat "too carbonated".

The report is available from EPA, IERL -- Cincinnati, Ohio.

SECTION XII

LEGAL REQUIREMENTS

Legal requirements for housing, production and labeling of FWB fall under applicable federal, state and local wine regulations. Federal requirements fall under several titles of 26 CFR (1954) Part 231 and 27 CFR (1972) Part 4.25.

In the final analysis, legal counsel recommends that the preferred course of action for initiating fermentation of FWB and marketing in any form would be consultation with local Bureau of Alcohol, Tobacco and Firearms (BATF) of the Treasury Department prior to any action or decision.

As a general guideline, it appears that to ferment FWB at a cheese plant or whey processing location will require at least separate facilities, isolated from the primary operation in specific ways.

Labeling requirements, as interpreted, do not make it clear that the FWB can or cannot be called a "wine"; in any event it would probably have to be identified as "whey wine", but might have to be handled by a "product name" route, listing whey as one of the major ingredients.

REFERENCES

1 United States Department of Agriculture Crop Reporting Board. SRS, USDA - Da 2-1 (74).

2 Unites States Department of Agriculture Crop Reporting Board. SRS, USDA - Da 2-1 (77).

3 Utilization of Cheese Whey for Wine Production. Department of Food Science and Technology, Oregon State University, Corvallis, Oregon 97331. EPA Grant No. R-803301.

4 Federal Taxpaid Wine Bottling Houses Regulations. 26CFR (1954) Part 231.

5 Federal Wine Labeling and Advertising. 27CFR (1972) Part 4.25

APPENDIX A. DESCRIPTIVE FLAVOR ANALYSIS

DESCRIPTIVE FLAVOR ANALYSIS PANEL

The Foremost Descriptive Flavor Analysis Panel uses a method of analysis developed by the Arthur D. Little Company in 1949. It involves 4-6 highly trained personnel who analyze products by describing their sensory characteristics. The Foremost panel is trained to objectively analyze aroma, flavor and texture of food and some non-food products such as pharmaceuticals. Also, aroma and flavor contributions, if any, of packaging materials on food products can be analyzed.

1. SCOPE AND APPLICATION

Descriptive flavor analysis describes in proper perspective all detectable characteristics of the aroma and flavor of a product. The method provides a complete word description ("analysis" or "profile") of a sample. Several analyses can be compared to show differences among a group of samples. Or, for a particular sample, the panel can define the product's characteristics in descriptive terminology, which can in turn be used in the development of consumer questionnaires or as an aid in defining consumer responses. The panel can also define in descriptive terms the effect of ingredient or process changes on total flavor impression of a product and/or its individual character notes. Other areas in which Foremost has found the Profile Panel to be of assistance are: as a guide in assessing new processing methods and equipment and their effect on the flavor of a product; in monitoring products on a year-to-year basis for flavor changes; in determining when the laboratory formulation has achieved the flavor goal established for a new product; and in defining the flavor, aroma and textural characteristics of competitive products.

2. SUMMARY OF METHOD

The Profile method requires a panel of four to six trained flavor analysts who function as a unit under the direction of a panel leader to produce a word description of the product. During the first phase of each panel session (referred to as the closed session), panel members analyze their samples independently. Subsequently, the panel leader initiates the second phase (open session), during which individual findings are discussed, with references to standards if necessary, to help achieve unanimity of expression. Since the word "analysts" implies an objective approach by definition, panel members merely record all perceptible sensations with no reference whatsoever to preference.

Profile analysts are individuals who, through a screening procedure, have demonstrated the three basic qualifications for panel membership:

1. Normal ability to taste and smell,

2. Above average interest in odor and flavor, and

3. Certain personality requirements.

Further, they are individuals who have undergone extensive training; individuals who, through daily participation in a panel training work program, have been exposed to a wide variety of experiences; individuals who, through use of reference standards, resolve differences in terminology, and thus, speak a common language.

The flavor profile consists of five basic parts:

1. The character notes,

2. Their intensities,

3. Order of appearance,

4. Initial overall impression or amplitude, and

5. Aftertaste

Character notes are the sensations perceived by the senses of taste, smell and feel. In aroma, character notes include aromatics and feeling factors; and in flavor, they include both these elements plus the basic tastes of sweet, sour, salty and bitter. Aftertaste or persistent flavor is also reported. The panel assigns intensity levels to each character note using a 7-point scale ranging from threshold to strong. The panel also assigns an overall impression or amplitude rating of the products evaluated. The amplitude rating involves all of the qualities of the basic character as well as the non-analyzable portion, which together create the general flavor effect. The amplitude rating is high when the following hold true:

1. Early impact of appropriate flavor,

2. Rapid development of full flavor in the mouth, i.e., well blended.

3. No early or late off-notes in the aroma or flavor pattern (order of appearance),

4. Pleasant mouth sensations, and

5. Clean aftertaste and quick clean up of aftertaste.

Amplitude is a quality rating and not a preference score. A simple, constant word scale is used for the amplitude rating. The scale is as follows: L=Low, LM=Low to Medium, M=Medium, MH=Medium High and H=High.

APPENDIX B. ECONOMICS OF FERMENTED WHEY BEVERAGE PROCESSING

This section presents costs involved in manufacturing a fermented whey beverage product, projected from pilot experience. Consideration is given to the costs of processing, formulating and bottling. Thus, the costs are for bottled product going into storage. Costs for tax, warehousing, distribution, advertising and other business costs will not be considered at this time.

Processing Costs

For this analysis, two distinct scales of wine production will be used as examples. To represent the small, independent cheese manufacturer with limited capability for distribution of a Fermented Whey Beverage (FWB) product, the conversion of 3,785 liters of whey per day, 250 days per year is considered. On the other hand, for the commercial dairy/cheese plant attempting a third business area for expansion, a 378,500 liters per day, 350 day per year enterprise is evaluated.

General Assumptions of Cost Estimates

The following general assumptions will be made for costing purposes:

1. Processing on continuous equipment will involve 20 hours per day when applicable, leaving four hours for cleaning and/or sanitizing.

2. The following operating cost assumptions will be made:

    a. Building Costs: Estimate process operation area, in square meters, and charge $646 per square meter building costs. This is depreciated over 25 years on a straight line basis.

    b. Equipment Costs: Estimate equipment costs and depreciation over ten years on a straight line basis.

    c. Labor Costs: Operator labor figured at $10 per hour, including fringe benefits.

    d. Maintenance Costs: Maintenance labor costs figured at 5% of yearly capital depreciation amount for the equipment.

    e. Spare Parts: Supply of spare parts figured at 1.0% of original capital costs.

    f. Power: Figured at $0.025 per Kwhr.

g. Water: Figured at $0.25 per 3,785 liters.

h. Acid Material: Figured at $10 per 45.4 kilograms.

i. Caustic Material: Figured at $18 per 45.4 kilograms.

Some specific cost factors may apply to particular unit operations and will be enumerated at that time.

SEPARATION

COST ELEMENTS		3,785 LITERS/DAY OPERATION	378,500 LITERS/DAY OPERATION
1.	Equipment		
	a. Capacity, liters per minute	13.25	454
	b. Cost	$20,000*	$115,000
	c. Yearly Depreciation	$ 2,000	$ 11,500
2.	Power		
	a. HP Requirement	10	50
	b. Kwhr Requirement	9.0	36.0
	c. Yearly Cost	$ 338	$ 5,040
3.	Labor		
	a. Daily Manhours	0.5	1.5
	b. Yearly Cost	$ 1,250	$ 5,250
4.	Maintenance		
	a. 5% of Yearly Capital Depreciation	$ 175	$ 575
5.	Subtotal	$ 3,763	$ 22,365
6.	Overhead		
	a. 40% of Subtotal	$ 1,505	$ 8,946
7.	Yearly Cost for Separation	$ 5,278	$ 31,311
8.	Cost per Liter FWB Base	$ 0.0056	$ 0.00024

* Only one-half of clarifier costs included here because the same machine is used for clarifying ferment, and the second half of costs are included at that point.

ULTRAFILTRATION

COST ELEMENTS		3,785 LITERS/DAY OPERATION	378,500LITERS/DAY OPERATION
1.	Equipment		
	a. Membrane Area, Square Meters	13.9	465
	b. System Cost	$17,000	$250,000
	c. Yearly Depreciation	$ 1,700	$ 25,000
2.	Building		
	a. Area, Square Meters	9.3	186
	b. Yearly Depreciation	$ 240	$ 4,800
3.	Power		
	a. HP Requirements	7.5	75
	b. Kwhr Requirements	8.3	50.0
	c. Yearly Costs	$ 518	$ 8,750
4.	Labor		
	a. Daily Manhours	1.5	4.0
	b. Yearly Costs	$ 3,750	$ 14,000
5.	Maintenance		
	a. 5% of Capital Depreciation	$ 85	$ 1,200
6.	Membrane Lease/Rental		
	a. $96.87/Square Meter/Year	$ 1,350	$ 45,000
7.	Cleaning Supplies		
	a. Acid: 1 lb/9.3 Square Meters Membrane - Day	$ 75	$ 3,500
	b. Caustic: 5 lb/9.3 Square Meters Membrane - Day	$ 337.50	$ 15,750
8.	Water	$ 25	$ 1,000
9.	Subtotal	$ 8,080.50	$119,000
10.	Overhead		
	a. 40% of Subtotal	$ 3,232	$ 47,600
11.	Yearly Cost for Ultrafiltration	$11,312	$166,600
12.	Cost Per Liter FWB Base	$ 0.0119	$ 0.0013

FERMENTATION

COST ELEMENTS		3,785 LITER/DAY OPERATION	378,500 LITER/DAY OPERATION
1.	Equipment		
	a. Fermentor Capacity, Liters	37,850	3,785,000
	b. Costs	$ 25,000	$ 333,000
	c. Yearly Depreciation	$ 2,500	$ 33,300
2.	Ingredients		
	a. Whey	$ 0.00	$ 0.00
	b. Dextrose		
	1. 0.22 kg/liter FWB base	212.245 kg	29,714,300 kg
	2. $0.068 kilogram	$ 70,125	$9,817,500
	c. Yeast & Potassium Metabifulfite		
	1. $0.0132/liter FWB base	$ 12,500	$1,750,000
3.	Building		
	a. Area, Square Meters	232	-
	b. Cost at 323 Square Meter	$ 75,000	-
	c. Yearly Depreciation	$ 3,000	-
4.	Power		
	a. HP Requirement	20	150
	b. Kwhr Requirement	19.0	125.34
	c. Yearly Cost	$ 475	$ 4,386
5.	Labor		
	a. Daily Manhours	1.5	2.5
	b. Yearly Costs	$ 3,750	$ 8,750
6.	Maintenance		
	a. 5% of Capital Depreciation	$ 125	$ 1,665
7.	Subtotal	$ 92,475	$11,615,601
8.	Overhead		
	a. 40% of Subtotal	$ 36,990	$ 4,646,240
9.	Yearly Cost for Fermentation	$129,465	$16,261,841
10.	Cost Per Liter FWB Base	$ 0.1368	$ 0.1227

CLARIFICATION

COST ELEMENTS	3,785 LITERS/DAY OPERATION	378,500 LITERS/DAY OPERATION
Cost/Liter FWB Base*	$0.0056	$0.00024

* Cost considered same as initial separation

FILTRATION

COST ELEMENTS		3,785 LITERS/DAY OPERATION	378,500 LITERS/DAY OPERATION
1.	Equipment		
	a. Capacity, Liters per Minute	13.25	454
	b. Cost	$ 7,800	$ 26,000
	c. Yearly Depreciation	$ 780	$ 2,600
2.	Building		
	a. Area, Square Meters	4.65	9.29
	b. Cost	$ 3,000	$ 6,000
	c. Yearly Depreciation	$ 120	$ 240
3.	Power		
	a. HP Required	1.0	5.0
	b. Kwhr Required	1.09	5.25
	c. Yearly Cost	$ 41	$ 248
4.	Labor		
	a. Daily Manhours	2.0	3.0
	b. Yearly Cost	$ 5,000	$ 10,500
5.	Maintenance		
	a. 5% of Capital Depreciation	$ 39	$ 130
6.	Supplies		
	a. Pad and Aid	$ 1,500	$ 8,000
7.	Subtotal	$ 7,480	$ 21,718
8.	Overhead		
	a. 40% of Subtotal	$ 2,992	$ 8,687
9.	Cost for Filtration	$10,472	$ 30,405
10.	Cost/Liter FWB Base	$ 0.0111	$ 0.00024

DEASHING (ION EXCHANGE vs ELECTRODIALYSIS)

COST ELEMENTS		3,785 LITERS/DAY OPERATION		378,500 LITERS/DAY OPERATION	
		IE	ED	IE	ED
1.	Equipment				
	a. System Cost	$13,000	$65,000	$200,000	$611,000
	b. Yearly Depreciation	1,300	6,500	20,000	61,100
2.	Building				
	a. Area, Square Meters	23.23	23.23	92.94	92.94
	b. Cost	$15,000	$15,000	$ 60,000	$ 90,000
	c. Yearly Depreciation	$ 600	$ 600	$ 2,400	$ 3,600
3.	Labor				
	a. Daily Manhours	1.33	1.33	8.0	8.0
	b. Yearly Cost	$ 3,325	$ 3,325	$ 28,000	$ 28,000
4.	Power				
	a. HP Required	0.5	-	10.0	-
	b. Kwhr Required	746/yr	17,000/yr	52,220/yr	2.1 Mil/yr
	c. Yearly Cost	$ 19	$ 425	$ 1,306	$ 52,500
5.	Maintenance				
	a. 5% Capital Depreciation	$ 65	$ 325	$ 1,000	$ 3,055
6.	Water				
	a. Yearly Cost	$ 31	$ 100	$ 3,100	$ 10,000
7.	Chemicals				
	a. Acid	$ 1,167		$116,700	
	b. Caustic	$ 3,373		$337,300	
	c. Yearly Cost	$ 4,540	$ 1,000	$454,000	$100,000
8.	Subtotal	$ 9,880	$12,275	$509,806	$258,255
9.	Overhead				
	a. 40% Subtotal	$ 3,952	$ 4,910	$203,922	$103,302
10.	Yearly Cost for Deashing	$13,832	$17,185	$713,728	$361,557
11.	Cost Per Liter FWB Base	$ 0.0146	$ 0.0183	$ 0.0054	$ 0.0027

SUMMARY OF FWB BASE PROCESSING ECONOMICS

COST ELEMENTS			
1.	Separation	0.0056	0.0024
2.	Ultrafiltration	0.0119	0.0013
3.	Fermentation (includes ingredients)	0.1368	0.1227
4.	Clarification	0.0056	0.00024
5.	Filtration	0.0111	0.00024
6.	Deashing	0.0146	0.0027
	a. ED	0.0182	0.0027*
	b. IE	0.0146*	0.0054
7.	Processing Cost/Liter FWB Base	0.1856	0.1275

* Method Selected

FORMULATING COST

(Based on National Market Test Formulation)

COST ELEMENTS		3,785 LITERS/DAY 250 DAY OPERATION	378,500 LITERS/DAY 350 DAY OPERATION
1.	Flavoring Material		
	a. 946,250 Liter *3.18%* $3.96/Liter	$119,159	
	b. 132,475,000 Liters *3.18%* $3.17/Liter		$13,354,275
2.	Invert Syrup		
	a. 946,250 Liters *8.25%* $2.65/Liter	$206,093	
	b. 132,475,000 Liters *8.25%* $1.85/Liter		$20,218,997
3.	Malic Acid		
	a. 946,250 Liters *0.0026 Kg./Liter $15.42/Kg.	37,937	
	b. 132,475,000 Liters *0.0026 Kg/Liter $11.00/Kg.		$ 3,788,785
4.	Alcohol Adjustment Water	No cost, assuming feremented to proper alcohol level.	
5.	Total Formulation Costs	$363,189	$37,362,057
6.	Costs per Liter[1] Formulated Wine	$ 0.3691	0.2712

[1] One Liter FWB Base = 1.04 Liters Formulated Wine Product

CARBONATION

COST ELEMENTS	3,785 LITERS/DAY OPERATION	378,500 LITERS/DAY OPERATION
1. Equipment		
a. System Cost	$ 7,500	$ 55,000
b. Yearly Depreciation	750	5,000
2. Building		
a. Area, Square Meters	14	186
b. Yearly Depreciation	$ 360	$ 4,800
3. Labor		
a. Daily Manhours	3.0	3.0
b. Yearly Cost	$ 7,500	$ 7,500
4. Carbon Dioxide		
a. Quantity Gas per Liter	1.8 Volumes	- 1.8 Liters CO_2/ LITER
b. Yearly Quantity, Liter	1,958,738	274,223,250
c. Cost per Liter CO_2	$ 0.0030	$ 0.00030
d. Yearly Cost	$ 5,830	$ 81,128
5. Power		
a. HP Required	3.0	20.0
b. Kwhr Required	2.97	18.91
c. Yearly Cost	$149	$946
6. Maintenance		
a. 5% of Yearly Capital Depreciation	$38	$275
7. Subtotal	$14,626	$100,148
8. Overhead		
a. 40% Subtotal	$ 5,851	$ 40,059
9. Yearly Cost for Carbonation	$20,478	$140,207
10. Cost Per Liter Flavored Wine	$ .0216	$ 0.001018

BOTTLING

COST ELEMENTS		3,785 LITERS/DAY OPERATION	378,500 LITERS/DAY OPERATION
1.	Equipment		
	a. Filler Cost	$ 25,000	$ 1,000,000
	b. Yearly Depreciation	$ 2,500	100,000
2.	Building		
	a. Area, Square Meters	28	465
	b. Yearly Depreciation	720	12,000
3.	Labor		
	a. Daily Manhours	8.0	8.0
	b. Yearly Cost	$ 20,000	$ 28,000
4.	Bottles		
	a. Yearly Quantity	$984,100	$137,774,000
	b. Cost per Bottle	$ 0.2527	$ 0.1969
	c. Yearly Cost	$248,682	$ 27,127,700
5.	Caps		
	a. Yearly Quantity	$984,100	$137,774,000
	b. Cost per Cap	$ 0.0134	$ 0.0112
	c. Yearly Cost	$ 13, 187	$ 1,543,069
6.	Power		
	a. HP Required	1.0	40.0
	b. Kwhr Required	1.10	36.29
	c. Yearly Cost	$ 55	2,540
7.	Maintenance		
	a. 5% Yearly Capital Depreciation	$ 125	5,000
8.	Subtotal	$285,269	$ 28,818,309
9.	Overhead		
	a. 40% of Subtotal	$114,108	$ 11,527,324
10.	Yearly Costs for Packaging	$399,377	$ 40,345,633
11.	Cost per Liter Flavored Wine	$ 0.4058	0.2928